Exploring the Determinants for Grading Malaysian Rice

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Abstract: Rice plays a significant role in Malaysian economy especially for states in the Northern Region. Rice grading is important in determining rice quality and its subsequent price in the market. It is an important process applied in the rice production industry with the purpose of ensuring that the rice produced for the market meets the quality requirements of consumer. Two important aspects that need to be considered in determining rice grades are grading technique and determinants to be used for grading (usually referred as rice attributes). This article proposes the list of determinants to be used in grading Malaysian rice. Determinants were explored through combination of extensive literature review and series of interview with the domain experts and practitioners. The proposed determinants are believed to be beneficial to BERNAS in improving the current Malaysian rice grading process.

Index Terms: *Rice grading, Malaysian rice, rice grade, grade determinants*

I. INTRODUCTION

Rice grading plays an important role in the determination of rice quality and its subsequent price in the market. It is an important process applied in the rice production industry with the purpose of ensuring that the rice produced for the market meets the quality requirements of consumer [1]. Two important aspects that need to be considered in determining rice grades; grading technique and determinants to be used for grading (usually referred as rice attributes).

Rice quality is crucial and important in rice production. The quality of rice can be determined based on many criteria and not limited to types of rice, but it should focus on other aspects; crop environment, harvesting, processing, production and others [2]. Quality of rice mostly indicated by two main characteristics; physical and chemical characteristics [3].

In Malaysia, the main organization in rice industry which manages and controls the quality of rice is Padiberas Nasional Berhad (BERNAS). BERNAS plays important roles in managing domestic rice production. They involved in the procurement and processing of rice including the process of grading. As the main organization, BERNAS manages 45% of the local rice demand and 24% of the paddy market [2].

Many scholars worked on different methods of grading rice. However, works focusing on grading rice in Malaysia are almost none. Hence this study is focusing on the determining criteria for grading Malaysian rice by conducting a series of comparison study between the current rice grading model and methods in the northern states of Peninsular Malaysia. These identified criteria are hoped to be applied in designing a standard rice grading system nationwide.

Currently, rice grades and prices in Malaysia are determined by zones. For example, Selangor is using a different grading system which focusing on different criteria, while states in the northern region are using a different approach and criteria. This article focuses on grading approaches in the Kedah, the rice-bowl state of Malaysia. Thus, discussion will be focused on the types of rice planted and harvested in the mentioned state.

This article is organized as follows; Section Two discusses rice grading and its importance. Discussion also covers the current approaches of rice grading in Kedah. Methodology of determining the proposed determinants is covered in Section Three. Section Four discussed the proposed determinants while Section Five covers concluding remarks of this article.

II. RICE GRADING

Rice grading is essential in determining rice quality. Rice quality usually indicated by the grades which will determine the price. Rice grading involved two main processes which begin with rice sorting (depending on certain criteria) and assigning grade (or class) based on the sorted category. In rice production industry, rice grading plays a crucial and important role in determining the quality of rice and its subsequent price in the market. Rice grading is conducted in ensuring that the rice produced for the market meets the quality requirements of consumer.

Two important aspects that need to be focused in determining rice grades; grading method and determinants to be used for grading (rice attributes).

Many approaches and techniques have been used in the determination of the features of rice for grading purpose. These are the image processing together with Neural Network (NN), Wavelet Packet and Support Vector Machine, Contacting Angle Analysis method (separating contacting rice grain), Multi-threshold method based on maximum entropy (chalkiness), Minimum rectangle (MER)(length and width), image processing and the Adaptive Network Based Fuzzy Inference System (ANFIS),

image processing, image processing and NN with support from computer vision systems and machine vision systems. Many scholars such as [8,9,10,11,12] utilized combination of image processing and NN techniques in their works. To extract features of rice, image processing has been used. Based on the extracted features, rice will be graded by using NN.

In Malaysia, enforcement in rice grading and determination of rice grading are done as legislated in Padi and Rice Control Act 1994. The criteria used for grading and determining the quality of rice grain is based on its length and whiteness. The content of head rice, length of grain, content of broken rice, and milling degree are the main criteria for grading of rice [2].

Main categories of Malaysian rice (which will determine the grade) are Super Special Tempatan 5, Super Special Tempatan10, Super (Local), Premium, Standard, Rebus, Pulut and Hancur. Besides managing local rice, BERNAS is also focusing on imported rice. Mustafa in his interview [6] stated that Malaysia imported rice from Thai, Vietnam, Pakistan, Myanmar, USA, Australia, Japan and India. Fragrant rice, Basmati, parboiled and glutinous rice are among imported rice available in Malaysian market [7].

To grade the rice, 11 characteristics or grading factors will be used. Main factors used in the current rice grading technique by BERNAS are based on the grain composition, milling quality, defectives and moisture of the rice. The purpose of grain composition analysis is to determine the percentage of kernel, head rice, big broken, small broken and brewer or chip. Milling quality consists of the whiteness, translucency and the milling degree. On the other hand, defectives referring to the irregularity in the appearance of the rice grain and this causes the rice to be downgraded [4,6]. The main factors are defectives in rice such as chalk, damage, color, immature, foreign matter, other seed, paddy etc. While the moisture in the rice grain is to determine the amount of water contained in the rice grain [21].

III. METHODOLOGY

Combination of systematic literature review, content analysis and series of interview with domain experts from BERNAS were involved in exploring the determinants for rice grading, particularly for Malaysian rice. Underlying theories and existing rice grading methods and features used from literature were thoroughly reviewed in identifying the determinants. Through systematic literature review, eleven works were identified and thoroughly studied. Comparison has been done mainly about the method and features or characteristic of rice that have been used for grading purposes.

Determinants are also acquired from series of interview involving domain experts from BERNAS and content analysis of the Padi and Rice Control Act 1994, the main act used for rice production industry. Main objective was to understand the current implementation of rice grading works in Malaysia. Interview was conducted with the quality management division in Jitra and the rice production division in Kompleks Beras BERNAS (KBB) Sungai Baru, Alor Star. Based on the information obtained, determinants

which currently used for rice grading were compared with the determinants identified from literature.

IV. FINDINGS

From eleven major models that have been thoroughly analysed, fourteen attributes have been identified, as listed in Table 1.

Table. 1 Determinants used in major existing works

No	Features	Formal representation
1	Texture	*Tx*
2	Color	*Co*
3	Chalky	*Ch*
4	Cracked	*Cr*
5	Immature	*Im*
6	Length	*Le*
7	Width	*Wi*
8	Varietal types	*Vt*
9	Brewer	*Bw*
10	Broken	*Br*
11	Head rice	*Hr*
12	Size	*Sz*
13	Shape	*Sh*
14	Dead	*De*

According to personal communication with BERNAS particularly with staff from Quality Management Division, current implementation of determining rice quality and rice grading are based on Act 54, Rice (Grade and Price Control) 1992 Amendment 2008. Based on the Act, there are seventeen determinants used at the moment.

Table. 2 Determinants used by BERNAS
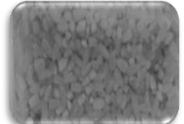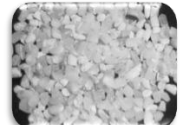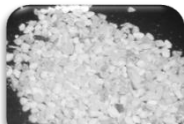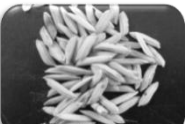
No	Rice features	Formal representation
1	Average Length	*Avgl*
2	Head rice	*Hr*
3	Big broken	*Bb*
4	Small Broken	*Sb*
5	Chalky	*Ch*
6	Immature	*Im*
7	Milling degree	*Md*
8	Red streak kernel	*RSK*
9	Damage/heat damage	*Da*
10	Foreign matter	*Fm*
11	Foreign grain	*Fg*
12	Paddy grain	*Pg*
13	Moisture content	*Mc*
14	Whole Kernel	*Wk*
15	Whiteness	*Wh*
16	Translucency	*Tr*
17	Brewer	*Bw*

In Malaysia the process of defining the features used by BERNAS are divided into four main stages that will determine the quality of rice.

In determining the quality of rice, the rice composition, the milling quality, its defectives and moisture content play the main role. Rice grading composition consists of five features or criteria (kernel, head rice, big broken, small broken and brewer/chip). Based on interview with domain experts and content analysis of the Padi and Rice act, seventeen features have been identified, as depicted in Table 2. Comparison and analysis have been conducted between determinants from these two resources. Redundancies were removed to get the final twenty-one attributes to be used in the proposed model. Table 3 shows graphical description of the final twenty-one determinants for grading Malaysian rice.

Table. 3 Graphical descriptions of the proposed determinants

No	Determinants	Graphical descriptions	No	Determinants	Graphical descriptions
1	Kernel (Kn)		12	Red streak kernel (RSK)	
2	Head rice (Hr)		13	Colour (Co)	
3	Big broken (bb)		14	Foreign matter (Fm)	
4	Small broken (Sb)		15	Average length (Avgl)	
5	Brewer (Bw)		16	Paddy grain (Pg)	
6	Whiteness (Wh)	-	17	Moisture content (Mc)	-
7	Translucency (Tr)	-	18	Size (Sz)	-
8	Milling degree (Md)	-	19	Shape (Sh)	-
9	Chalky (Ch)		20	Width (Wi)	-
10	Immature (Im)		21	Texture (Tx)	-
11	Damage (Da)				

The following are the definitions of each determinant that are obtained from Malaysia Standard 225:1997 (MS225:1997), specification for grading of mill rice (first version) and International Rice Research Institute (IRRI). IRRI is the nonprofit organization that handles research and training.

Kernel: Refers to the whole kernel without any broken part (MS 225: 1997). Permissible percentage for whole kernel is min 70% for Super Special Tempatan 5, Super Special Tempatan 10 and Super (Local) while premium is 60%. Kernel can be identified based on the length of more than 6.2mm.

Head Rice: Refers to kernels of milled rice of not less than 8/10 of the average length of grain (MS225: 1997). The calculation of head rice can be obtained from average grain length (A.G.L) and then multiplied by a factor of 8/10. The rice will be considered as head rice if the broken rice is larger than ¾ of the grain (IRRI, 2009). The permissible percentage (minimum) according to MS225:1997 and Rice (Grade and Price Control) (Amendment) Order 2008 is 90% for Super Special Tempatan 5, Super Special Tempatan 10, 85% for Super (local) and 55%for premium and standard.

Big Broken: Refers to broken kernels of milled rice of less than 8/10 and not less than 5/10 of the whole grain. The big broken can be determined by using indented plates, perforated sieves and hand picking. Based on the MS225:1997 and Rice (Grade and Price Control) (Amendment 2008), the permissible percentage (maximum) for big broken is 4% for Super Special Tempatan 5, 8%Super Special Tempatan 10, 13% for Super (local) and 45%for premium and standard.

Small Broken: MS225:1997 defined small broken as broken which is less than 5/10 and not less than 2/10 of the whole grain. The permissible percentage (maximum) in rice grading is 1% for Super Special Tempatan 5, 2%Super Special Tempatan 10, 2% for Super (local) and 45%for premium and standard.

Brewer: After the milling process is complete, there are small pieces of broken pieces that are identified as brewer 18]. According to personal interview with Mushidah of BERNAS, brewer means the measurement is less than 2 parts. Brewer is one of the by-products of rice.

Whiteness: Whiteness occurs in milling process which is the whitening and polishing factor which affect the whiteness of rice grain. During milling the bran layer from brown rice is removed during whitening. In a personal communication with Alief on April 29,2012, he said that whiteness is measured by the Satake milling meter.

Translucency: Refers to percentage of light translucence through a kernel. It is clear and shiny. Translucency is defined as clarity of endosperm [18]. It can be measured by using Satake milling

Milling Degree: Milling degree is measured based on the total of external layer that removed from brown rice. It also known as a degree of bran removal. Rice grains have three layers that are husk layer, bran layer and the endosperm. Brown rice refers to white rice that still has the bran layer [19].Milling degree affects color and characteristic of rice cooking[1]. According to personal interview with Mushidah, a staff of BERNAS, there are three levels in milling degree that affect rice quality which are: extra well milling, reasonably well milled and slightly under milled. There are three range grades of milling degree that is used for determining rice quality; extra well milling, reasonably well milled and slightly under milled.

Chalky: It refers to kernels or pieces of kernels one-half or more of the surface of which is white like the colour of chalk. Chalk is measured by percentage. Based on MS225:1997 and Rice (Grade and Price Control) (Amendment 2008), the permissible percentage (maximum) 3% for Super Special Tempatan 5, 3%Super Special Tempatan 10, 3% for Super (local) ,7%for premium and 10% for standard.

Immature: Immature grain is shrunken grains that are chalky. The determination of chalky or immature grains shall are on a representative portion of not less than 50g of head rice (MS225, 1997). Immature also means the rice shape do not appear properly and the kernel are not full (half) and very slender.According to personal interview with Alief of BERNAS, immature rice that comes into the machine during rice processing will break and it becomes bran. The permissible percentage (maximum) 3% for Super Special Tempatan 5, 3%Super Special Tempatan 10, 3% for Super (local) ,7%for premium and 10% for standard. Percentage of immature is high in paddy and it can cause broken grains and brewer.

Damage: Damage grains are grains which are distinctly discoloured or damaged by water, insects, heat, or any other means. Parboiled grains when found in white rice are considered as damaged grains. Off-yellow coloured, insect bored and stained or spotted grains are included in the damaged grains (MS 225: 1997). Damaged rice is caused by heat, and the rice will be dark [18]. The permissible percentage (maximum) 0.5% for Super Special Tempatan 5, 0.5%Super Special Tempatan 10, 0.5% for Super (local) ,2%for premium and 100% for standard.

Red Streak Kernel: It refers to kernel which is marked with red lines on either side of it. The length of the streaks may be more than half of the length of the kernel but the surface is formed up by the streaks and are less than 255 of the area of the kernel (MS225:1997). The permissible percentage (maximum) 0% for Super Special Tempatan 5, 0%Super Special Tempatan 10, 0% for Super (local) 0.2%for premium and 8% for standard.

Colour: Color is one of the defectives features. It is one of the important aspects in rice grading because it affects the rice quality. Color in rice grain can be categorized as yellow or red color. Red color can be as that the kernel which has more than 25% of the surface is its red color [4]. Red color and yellow are caused by the overexposure in the wet environment. It won't affect the rice production but will downgrade the rice. The measure is based on percentage.

Foreign Matter: Foreign matter is anything other than rice which found together with rice grain. The content of other seeds or foreign matter are determined by the use of sieves or handpicking (MS 225: 1997).

Average Length: Average length is used to determine measurement for rice composition. Length according to MS225:1992 is length of grains which is the whole kernels of milled rice. The average lengths of grains are between 6.2 mm or more and less than 6.2 mm.

Paddy Grain: Paddy is unhusked grain of Oryza sativa, which with the hull and glumes enclosing in the kernel. This term therefore denotes rice in husk, after threshing and without any portion of the stalk (MS225: 1997). The allowable amount of paddy in 1kg of rice is not more than 10 grain.

Moisture Content: Refers to a feature to determine quality of rice. The allowed percentage of moisture content is 14% [3]. The moisture content is measured by the percentage.

SIZE. Size is defined as the length of rice such as extra-long, long, medium and short [3]. In Malaysia, size is used to determine the variety types. The category is; extra-long (more than 7.5 mm), long (6.6 to 7.5 mm), medium (5.51 to 6.6 mm), short (5.5mm or less).

Shape: Shape is the criteria used to identify the variety of rice. There are four categories of shape slender, medium, bold, and round [15]. In Malaysia, shape is also used to define variety types of rice.

Width: A feature that is important to determine the class or grade of the rice. In terms of width, Arborio styles are generally the widest, followed by short, medium and long. The width measurement is in mm unit [18].

Texture: Texture is about hardness, adhesiveness, cohesiveness, initial mouth feels, springiness, resilience, gumminess and chewiness of rice [18].Texture can be extracted by Mean (m), Standard deviation (σ), Entropy (e), Uniformity (U), Third moments, and Smoothness (3μ) [7].

V. CONCLUSIONS

Determinants for Malaysian rice grading are obtained from combination of extensive literature review, content analysis of the Rice (Grade and Price Control) 1992 Amendment 2008, and series of interview with BERNAS.

There are eleven major models have been thoroughly reviewed. Fourteen determinants have been extracted from these major models. Based on the existing models, comparison is done by comparing the methods, criteria/features of rice, advantages and disadvantages and accuracies of the models. Determinants from BERNAS are obtained from the Rice (Grade and Price Control) 1992 Amendment 2008 and series interview with BERNAS. Seventeen determinants have been identified. These determinants have been compared with the ones extracted from the existing models. Redundancies were removed and the final list of twenty-one determinants is proposed.

ACKNOWLEDGEMENT

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