**Chapter I**

**INTRODUCTION**

Rice is the staple food of the Philippines. It is a major agricultural commodity that is mass produced in the country. In the first half of 2015, around 7.6 million metric tons of rice is produced by the Philippines (Philippine Statistics Authority). The Philippine Grain Standardization Program is a government program spearheaded by the National Food Authority to provide commercial assessment standards for the determination of the grade and quality of milled rice products. The implementation of the program started on September 21, 2002. From its establishment, the National Grains Standard has been formed. The National Grains Standards defined the characteristics classification of the rice grain samples. Factors for determining grade include dimensional length, degree of milling, percentage by weight of broken kernels, brewers, red kernels, immature kernels, chalky kernels, damaged kernels, yellow kernels, age-related changes, and other characteristics. The grades are based on the percentage by weight of the classified grains to the overall weight of the product. The Grade 5 is the lowest and the Premium grade is the highest grade a milled rice product can be classified to. Moreover, the implementation of these standards in the market is expected to boost the quality of the rice products in the Philippines. The NGS not only defined provisions about grading, but several packaging regulations, labelling, and quality testing procedures are also outlined. The program institutionalizes the standards to promote inclusive growth and better-quality products. Using the standards retailers, farmers, and distributors can grade their products accordingly. However, the process of grading is still manual and is highly subjective. Assessment experts rely on their own perceptual inference and the manual measurement using precision tools only. The differences in the assessment could render the standards pointless.

Existing studies are aimed to develop simple, affordable, and accessible grading methodologies. Image processing techniques are the most common methods used to classify and grade rice grains based from different standards all over the world. Thresholding techniques were used to distinguish the chalky region of a grain and ultimately quantify its region percentage (Chandra, Barman, & Ghosh). The amount of the chalky region signifies the breaking capacity of the grain and this degrades the quality of the product. A lot of studies correlate the degree of milling of the rice products to its quality. A study made in 2001 monitors the degree of milling of rice grain samples using the whiteness of the rice grains (Yadav & Jindal). An image of the rice grain samples is obtained using CCD Camera mounted to a platform equipped with image enhancing components. The image is analyzed by a computer running an analysis software. Several studies even use machine learning algorithms to determine the grade of the milled rice. The machine learning program learned how to distinguish between grades when fed with the training data obtained from manual methods (Neelamegam. P, S, & Valantina.S.).

Even though there are a lot of studies directed towards fast and affordable rice grading, the standards from where they were based are diverse and local. They also tend to determine the grade of the rice products based on few factors. Moreover, there are currently no studies in the Philippines which are based on the National Grain Standards. This lack of study exposes the vulnerability of the current assessment methods of rice grain products in the Philippines. The grading procedure remains manual, highly subjective, and rely heavily to the expertise of the assessors. This has the potential to create sampling variations which may affect the general Philippine rice market.

The purposes of this study are to lessen the subjectivity of rice grading assessments based on the National Grain Standards by utilizing the consistency and precision of computer-aided assessments and to speed up the grading time. Using image processing methodologies, the study aims to develop a milled rice grading system that is portable and accessible to people and organizations who are working directly on rice like millers, distributors, and farmers. To meet these purposes, the following objectives are to be completed: (1) gather reference values for the evaluation of qualitative grading factors based on the definition of NGS and the assessment of rice-grading assessors; (2) develop an image acquisition and grade reporting platform that is portable and accessible to people who work in rice-related bodies; and (3) develop and implement an image processing application that will work with the portable platform to grade rice samples based on the NGS provisions and reference values.

The grade of a milled rice product affects its price. Therefore, it is essential to find a less subjective and more precise method of grading milled rice products. Fortunately, the NGS provided the data to accurately grade a product. A device that will produce precise and accurate grading based on the NGS can improve the profit of a rice business. Moreover, a device that is accessible and portable can reach even the remotest parts of the Philippines. This effectively extends the reach of the Philippine Standardization Program. In general, the potential impact of this study is related to increasing the productivity of the business by decreasing grading time, providing a fair and accurate grading method, and increasing the accessibility of the method to bigger demographics.

The study is limited to the definitions of the National Grain Standards and the reference values from rice-grading assessors. Moreover, the factors that will be considered by the portable grading system are: dimensional length, degree of milling, percentage by weight of broken kernels, brewers, red kernels, immature kernels, chalky kernels, damaged kernels, presence of foreign materials, and yellow kernels. The moisture content is excluded since this measurement is dependent on the age of the unhusked rice gain (palay) and the study is limited to milled rice. The study aims to develop a portable device that grade a rice sample based from an acquired image of non-overlapping rice grains in the sample. For portability, the device will be a standalone system powered by a battery. An image acquisition platform with constant lighting setup will be developed to reduce the perception variation of the images. The device is expected to display the grade of the rice sample along with the measured values of the following factors: rice gain count, dimensional length, degree of milling, percentage by weight of broken kernels, brewers, red kernels, immature kernels, chalky kernels, damaged kernels, foreign material count, degree of milling, and yellow kernels. Furthermore, the open-source Raspberry Pi will be used as the main computer of the device and the Open Source Computer Vision Library (OpenCV) with the Python interface and the other Python modules for the image processing application.